MESSAGE$_{ix}$ Workshop – Modelling Forum

MESSAGEix Workshop team:
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MESSAGEix Workshop, Previous Sessions

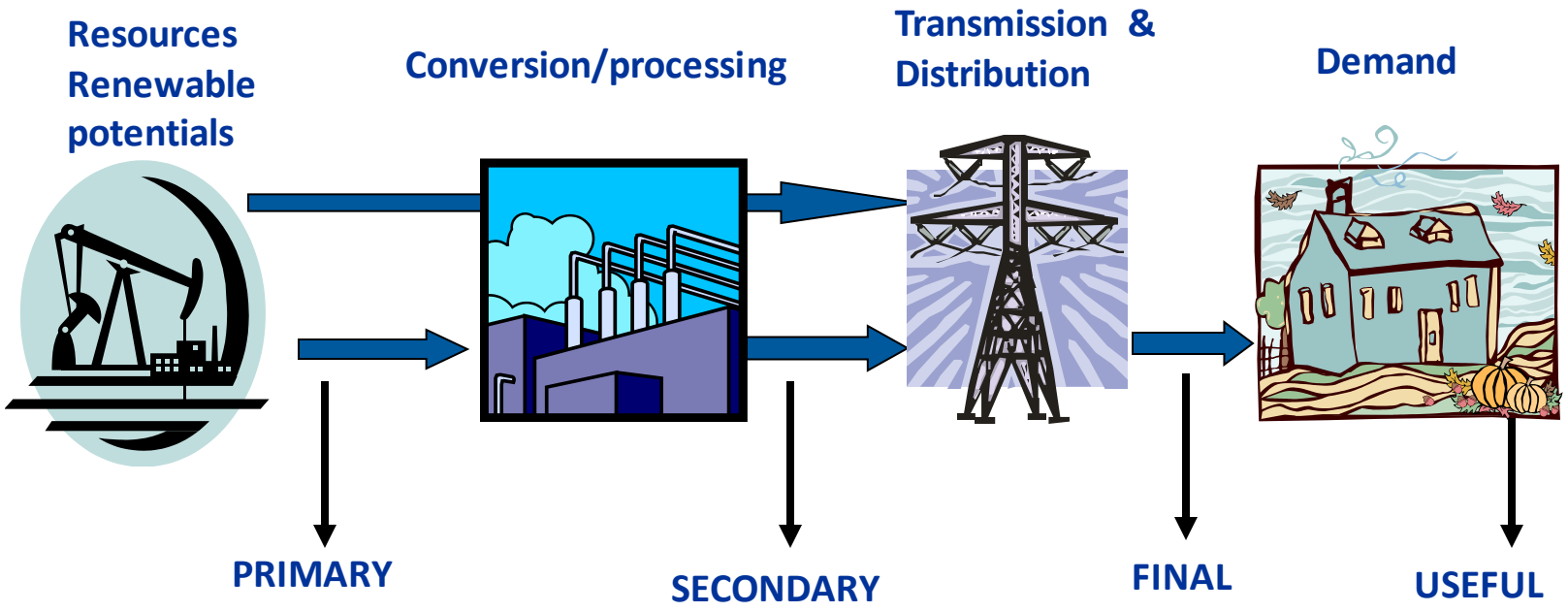
Recap…

- Session I: MESSAGEix framework software stack and their relationship
- Session II: MESSAGEix a cost minimization model for integrated assessment and energy modelling
- Session III: Building simple energy models and representing energy policies
- Session IV: Scientific model development, continuous integration, reporting/post-processing

MESSAGEix Workshop, Modelling Forum

Agenda

- Modelling of an energy system (group discussion)
- Migrating an existing model to MESSAGEix, and using Excel for adding scenario data
- Q&A



Group Discussion

Think individually and take notes (3 min)

- What will be your **application (use case)** of an energy system model?
- List maximum **three topics or elements** (e.g., sectors, processes, technologies, agents, …) that are important for your analysis.

Group discussion (15 min)

- Introduce yourself briefly
- Share your list of important elements with the rest of the group.
- Do you find common topics/areas for your analysis?
- Discuss if these can be represented using a (mathematical) model.

Group Discussion

Think individually and take notes (3 min)

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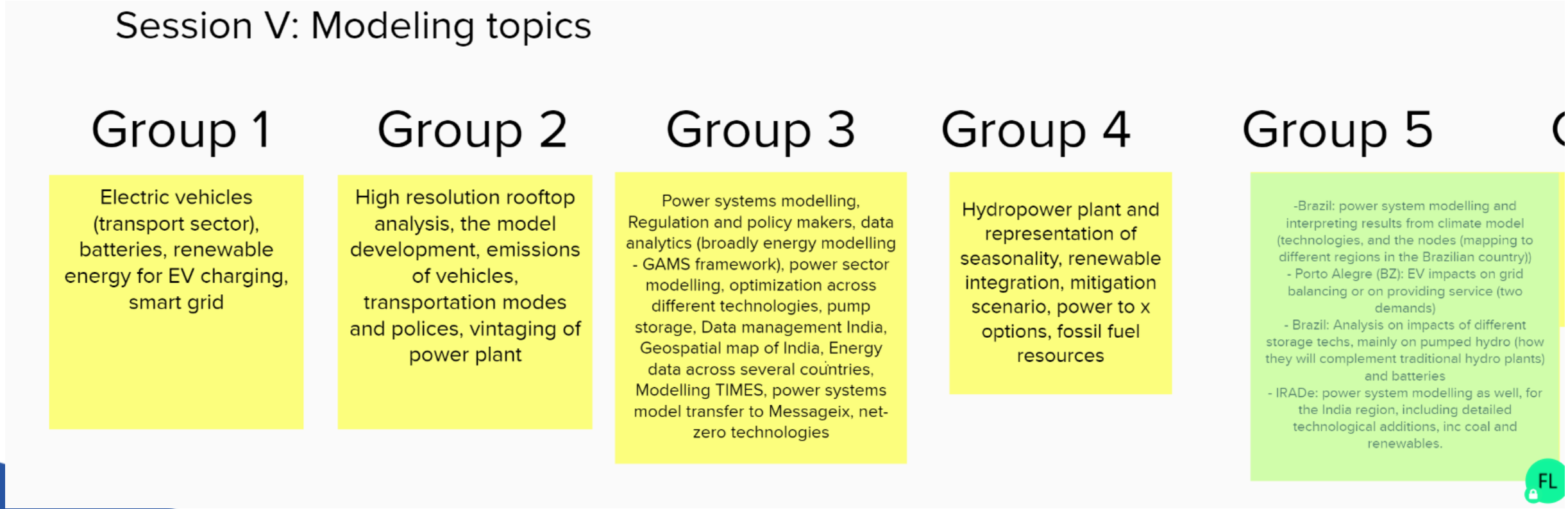


Building a model from scratch

Importing model data from Excel (read_excel())

- Suitable for small to medium models
- Easy to communicate with non-modelers
- Part or all the required data can be Fed to the model via Excel
- Excel structure must be compatible with MESSAGEix format of sets/parameters
- Not recommended for day-to-day Modeling work

Importing model data from Excel

In this example, we import the data directly from Excel and build the model.

In [ ]:
```
# Importing required packages and loading platform
import message_ix
import ixmp
mp = ixmp.Platform()
```

In [ ]:
```
# Creating a new (empty) scenario
scen = message_ix.Scenario(mp, model='Westeros Electrified',
                                scenario='baseline', version='new')
```

In [ ]:
```
# Reading data from Excel
scen.read_excel('C:/Users/zakeri/Documents/westeros_baseline.xlsx',
                add_units=True, commit_steps=True)
```

In [ ]:
```
# Solving scenario
scen.solve()
```

Building a model from scratch (2)

Exporting model data to Excel (to_excel())

- Useful for communicate with non-modelers

- Useful for sending data to a user not connected to your database

Exporting model data to Excel

```
In [ ]: scenario.to_excel('C:/Users/zakeri/Documents/westeros_baseline.xlsx')
```

Migrating an existing model to MESSAGEix

There is no right or wrong way!

- Depends on available skills and tools

- Excel can be used as a medium

Example: converting a model in MATLAB to the Excel format compatible with MESSAGEix, then reading the data from Excel to MESSAGEix

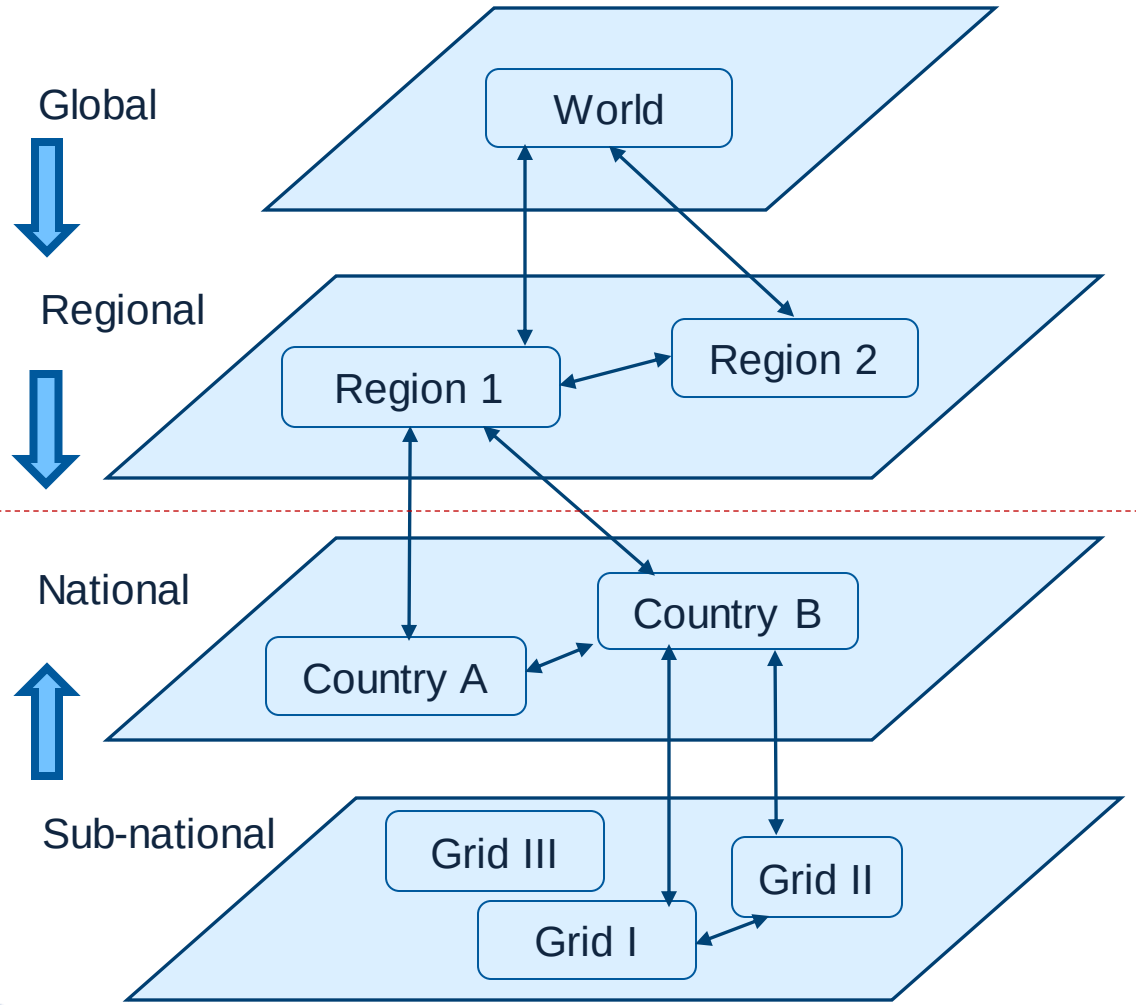
- For complex models developing scripts and functions for constructing the model data may be easier.

- In some cases, a combination of both methods can be applied.

	A	B	C	D	E	F	G
1	node_loc	technology	year_vtg	year_act	time	value	unit
2	Westeros	coal_ppl	690	700	year	1	-
3	Westeros	coal_ppl	690	710	year	1	-
4	Westeros	coal_ppl	690	720	year	1	-
5	Westeros	coal_ppl	700	700	year	1	-
6	Westeros	coal_ppl	700	710	year	1	-
7	Westeros	coal_ppl	700	720	year	1	-
8	Westeros	coal_ppl	710	710	year	1	-
9	Westeros	coal_ppl	710	720	year	1	-
10	Westeros	coal_ppl	720	720	year	1	-
11	Westeros	wind_ppl	690	700	year	0.36	-
12	Westeros	wind_ppl	690	710	year	0.36	-
13	Westeros	wind_ppl	690	720	year	0.36	-
14	Westeros	wind_ppl	700	700	year	0.36	-
15	Westeros	wind_ppl	700	710	year	0.36	-
16	Westeros	wind_ppl	700	720	year	0.36	-
17	Westeros	wind_ppl	710	710	year	0.36	-
18	Westeros	wind_ppl	710	720	year	0.36	-
19	Westeros	wind_ppl	720	720	year	0.36	-

Multi-node models in MESSAGEix

Possibility for nested and stand-alone models



- Global emission pathways
- Global energy demand
- Global energy trade

- Regional energy and emission markets
- Regional energy transitions
- Energy trade

- National energy and environmental policies
- Energy security
- Energy prices
- Implications of international agreements

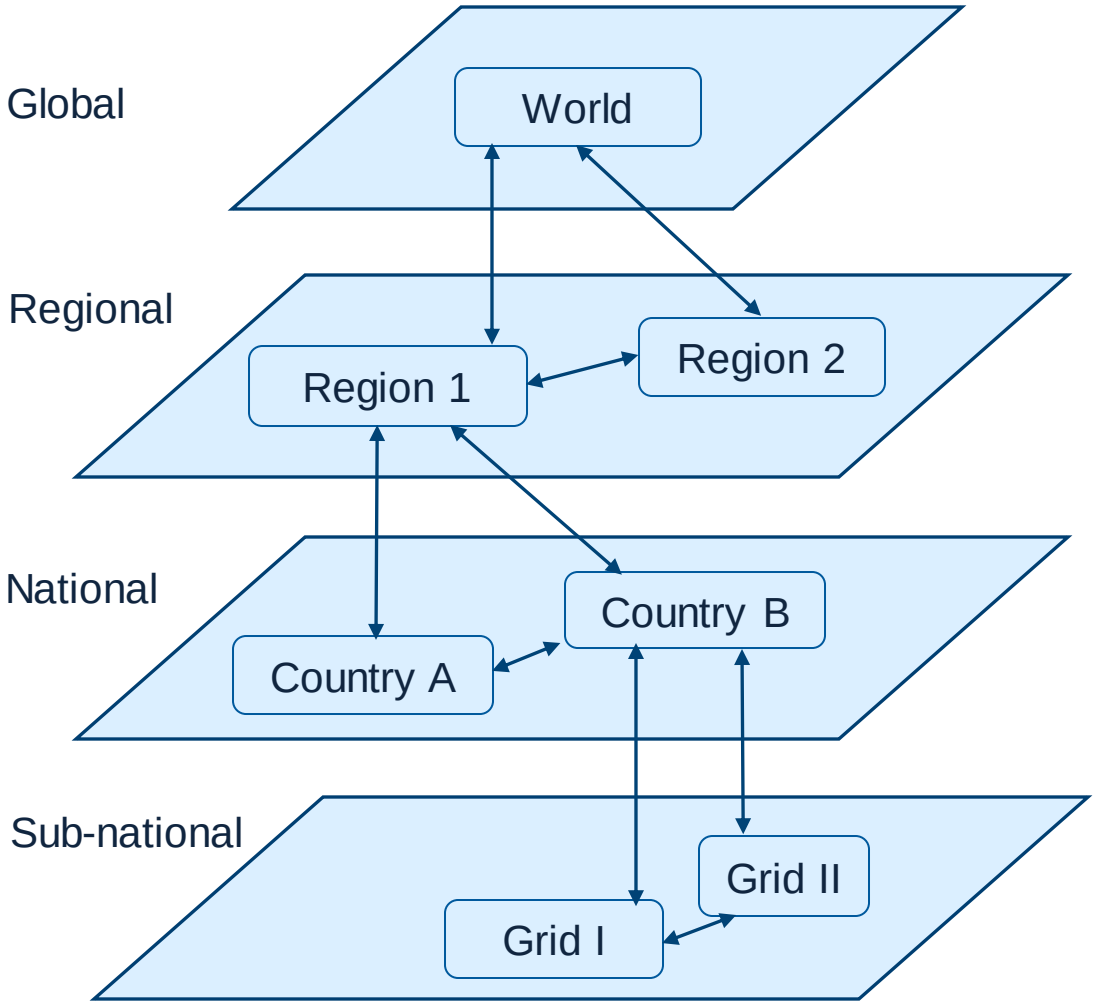
- Electricity transmission planning
- Renewable potentials and integration
- Energy demand

Multi-node models in MESSAGEix (2)

A flexible, spatial hierarchy method

- Each node is specified in a spatial level
- Each node has a parent node
- If not specified, "World" will be the parent node
- Flexible accounting of emissions

Example: a regional bound on emissions will take into account the emissions from all the nodes under that region



Multi-node models in MESSAGEix: Energy Trade

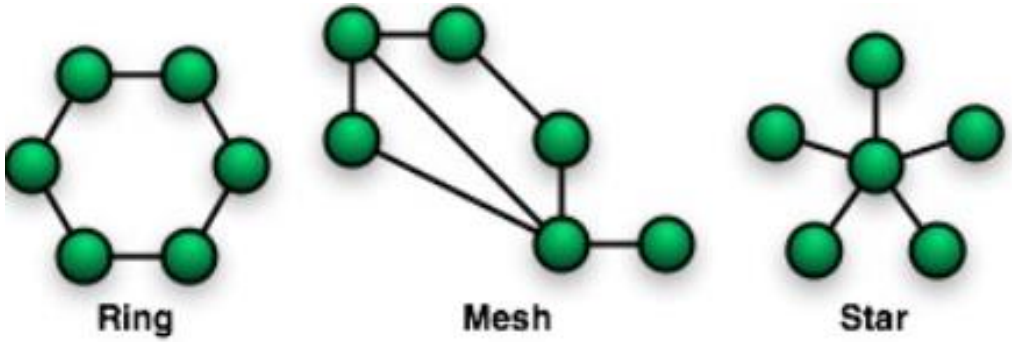
Possibility for different trade schemes

- Each node can be linked to others (or not)
- Pool-based energy markets (star structure)

Example: regional emission markets, national grid

- Meshed interlinkages, bi-directional (power systems)

or uni-lateral trade (gas interconnectors)



Trade representation in MESSAGEix:

- Trade routes as technologies can have capacity, costs, efficiency, emission factors, etc.
- Trade is represented as a transshipment model (i.e., no AC flow laws)
- Through parameters ***input*** and ***output*** of technologies (node of origin, location, node of destination)
- We can calculate share of import and export from total primary energy (import dependency)

Thank you very much for your attention!

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